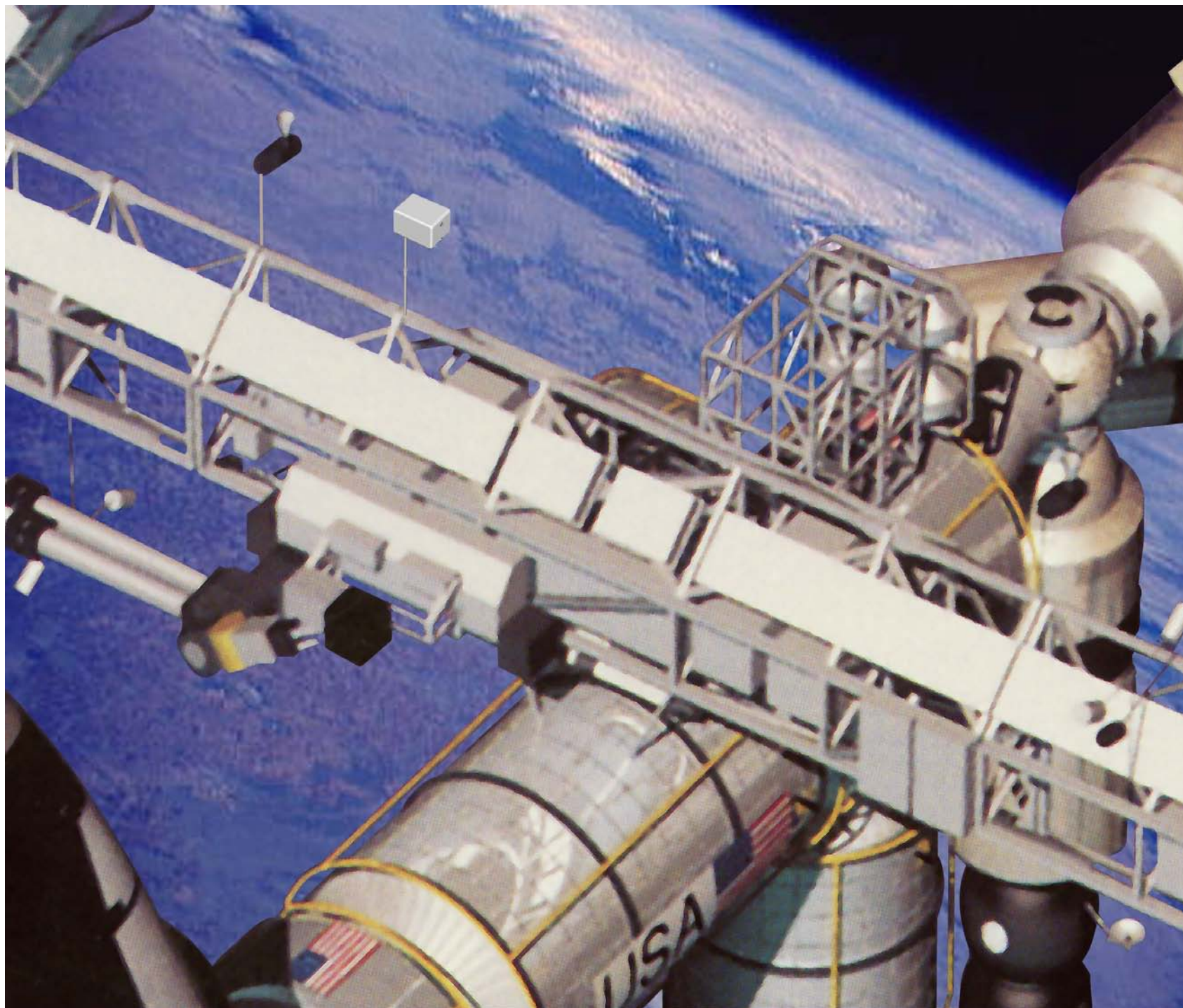
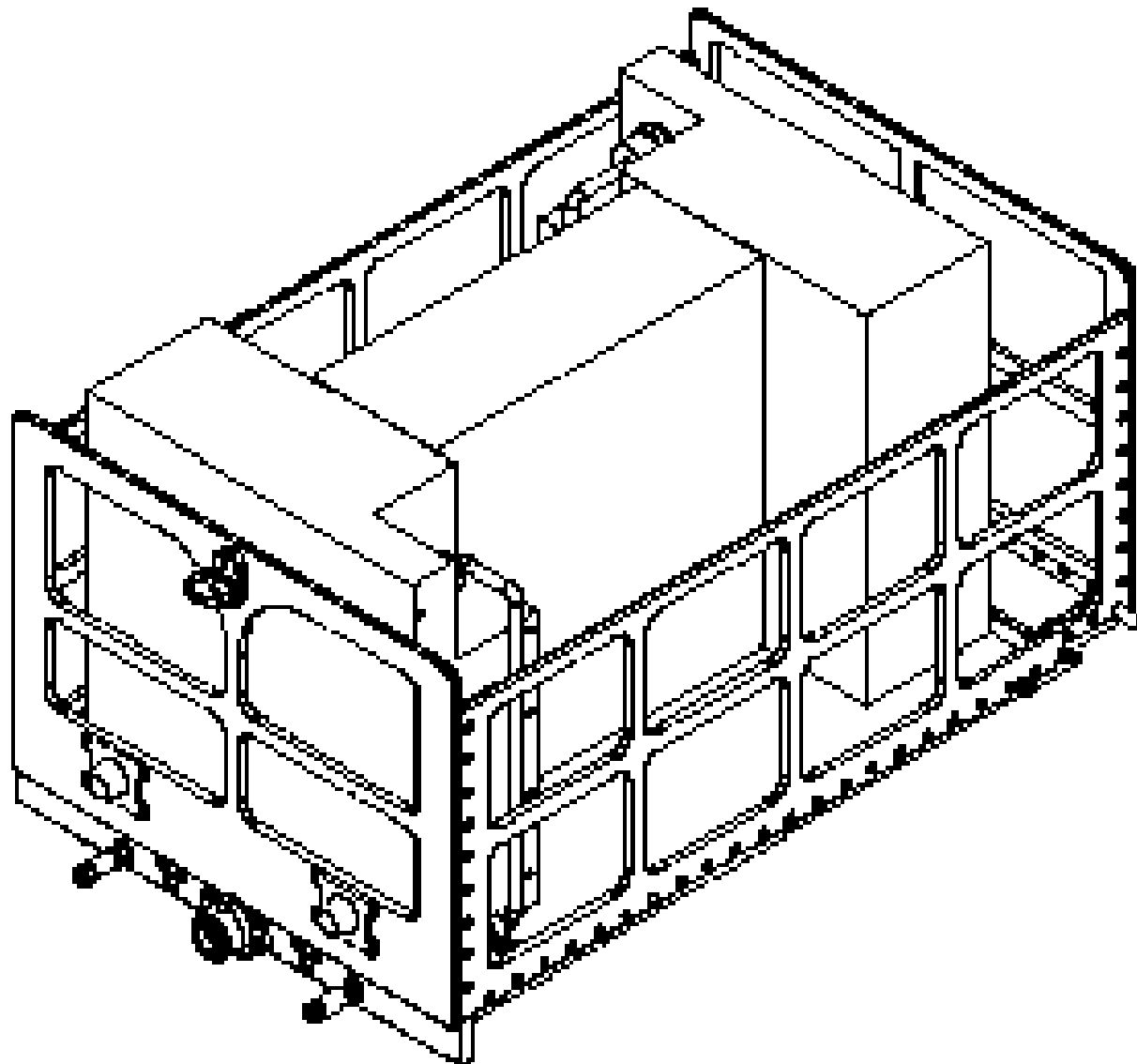


ISS ACTIVE DOSIMETRY SYSTEM

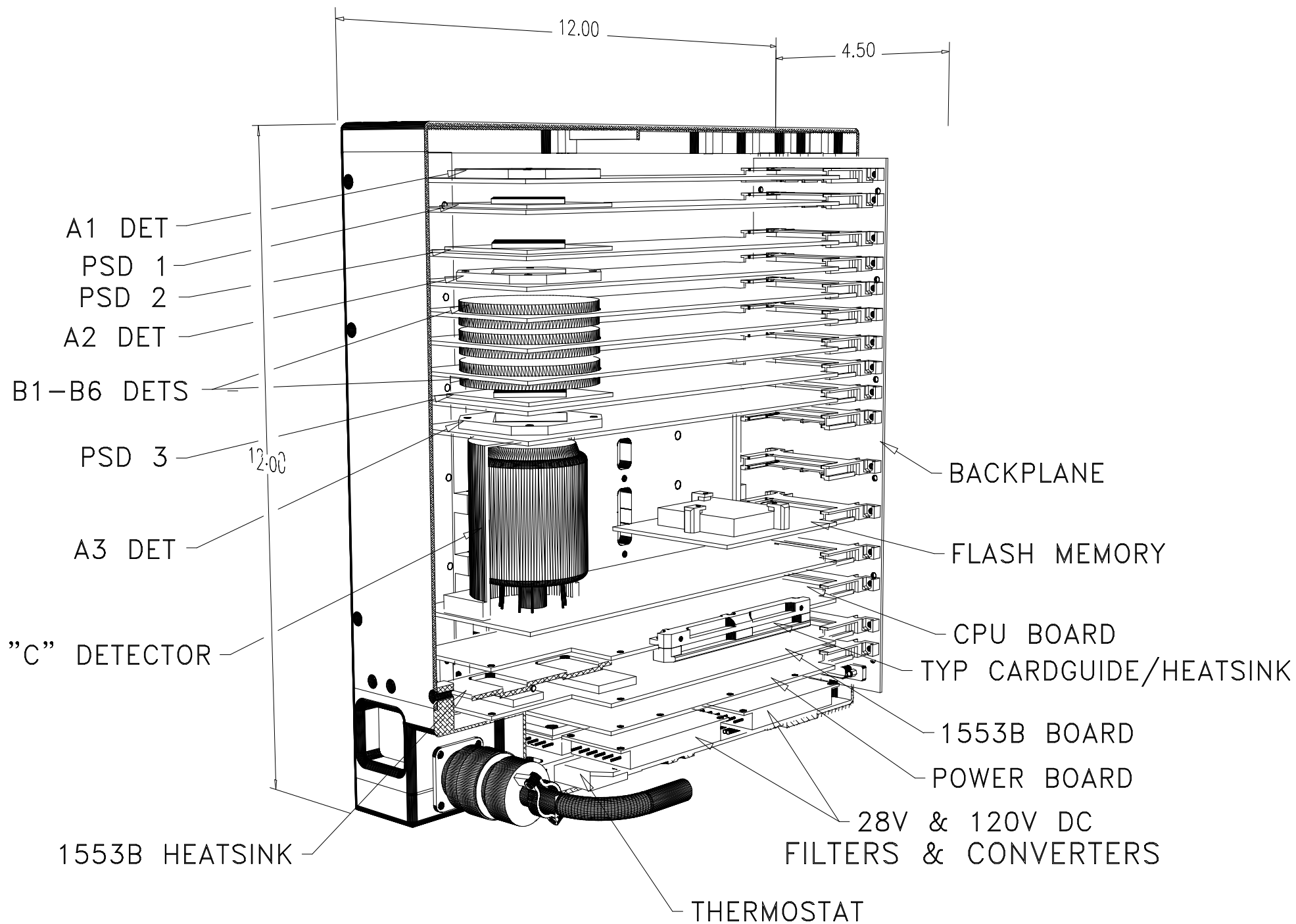
Gautam D. Badhwar
NASA Johnson Space Center, Houston, Texas 77058

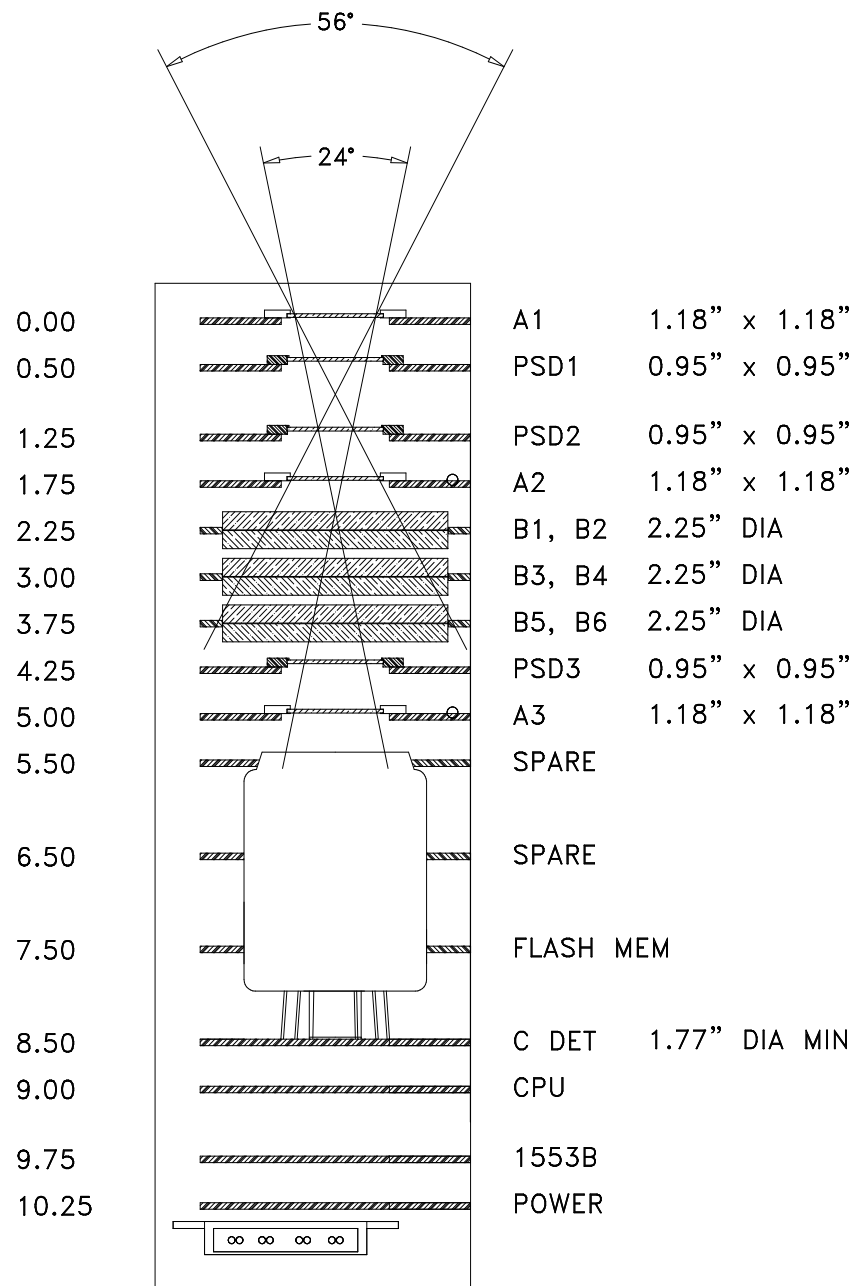
Presented at the NCRP Meeting at USRA, Houston, Texas 77058, December 8, 1999





The three spectrometers mounted in the 6B box





ACTIVE DOSIMETRIC SYSTEM

THERE ARE THREE ACTIVE DEVICES ON-BOARD THE ISS. THESE ARE :

- (1) EXTERNAL CHARGE PARTICLE DIRECTIONAL SPECTROMETER (EVCPDS)
- (2) INTERNAL CHARGED PARTICLE DIRECTIONAL SPECTROMETER (IVCPDS)
- (3) TISSUE EQUIVALENT PROPORTIONAL COUNTER (TEPC),
- (4) AND ALTHOUGH NOT CURRENTLY FUNDED OR APPROVED, A CREW ACTIVE DOSIMETER, WHICH IS A SMALL LIGHTWEIGHT DEVICE THAT OPERATES ON BATTERY POWER (CAD).

EVCPDS

- IT CONSISTS OF THREE PARTICLE SPECTROMETERS HOUSED IN A 6-B AVIONICS BOX. THE SPECTROMETERS ARE MOUNTED IN THREE MUTUALLY ORTHOGONAL DIRECTIONS, VIEW ALONG THE VELOCITY, ALONG THE ANTI-VELOCITY, AND NADIR DIRECTIONS, RESPECTIVELY. IT WILL BE MOUNTED ON THE S0 TRUSS.
- THE MOUNTING ALLOWS AN UNOBSTRUCTED VIEW AND PROVIDES TRULY FREE SPACE MEASUREMENTS.

- EACH SPECTROMETERS HAS THE FOLLOWING CAPABILITIES:
- CHARGE RANGE OF 1-26 WITH RESOLUTION IMPROVING WITH INCREASING CHARGE.
- ENERGY RANGE FOR PROTONS OF 15 TO 450 MeV WITH RESOLUTION OF ABOUT 3% AT THE LOWER ENERGY END INCREASING TO 20% AT THE HIGHER ENERGY END. BOTH THE LOWER AND UPPER ENERGY RANGE IS A FUNCTION OF PARTICLE CHARGE
- ABILITY TO DEFINE THE ARRIVAL DIRECTION OF AN INDIVIDUAL PARTICLE TO $\pm 2^{\circ}$ (1 SIGMA).
- PROVIDE TIME RESOLVED LINEAR ENERGY TRANSFER SPECTRA IN SILICON EACH DIRECTION.
- PROVIDE ABSORBED DOSE RATE WITH TIME IN EACH DIRECTION IN REAL-TIME FOR OPERATIONAL DECISIONS.
- ALTHOUGH THE SPECTROMETERS WERE *NOT* DESIGNED TO STUDY ELECTRONS, THE SPECTROMETER WOULD PROVIDE RATHER LIMITED ELECTRON ENERGY SPECTRUM IN THE 3 TO 8 MeV RANGE.
- A FRACTION OF TOTAL DOSE DUE TO ELECTRONS WOULD ALSO BE INCLUDED IN THE TELEMETERED ABSORBED DOSE TO THE GROUND.

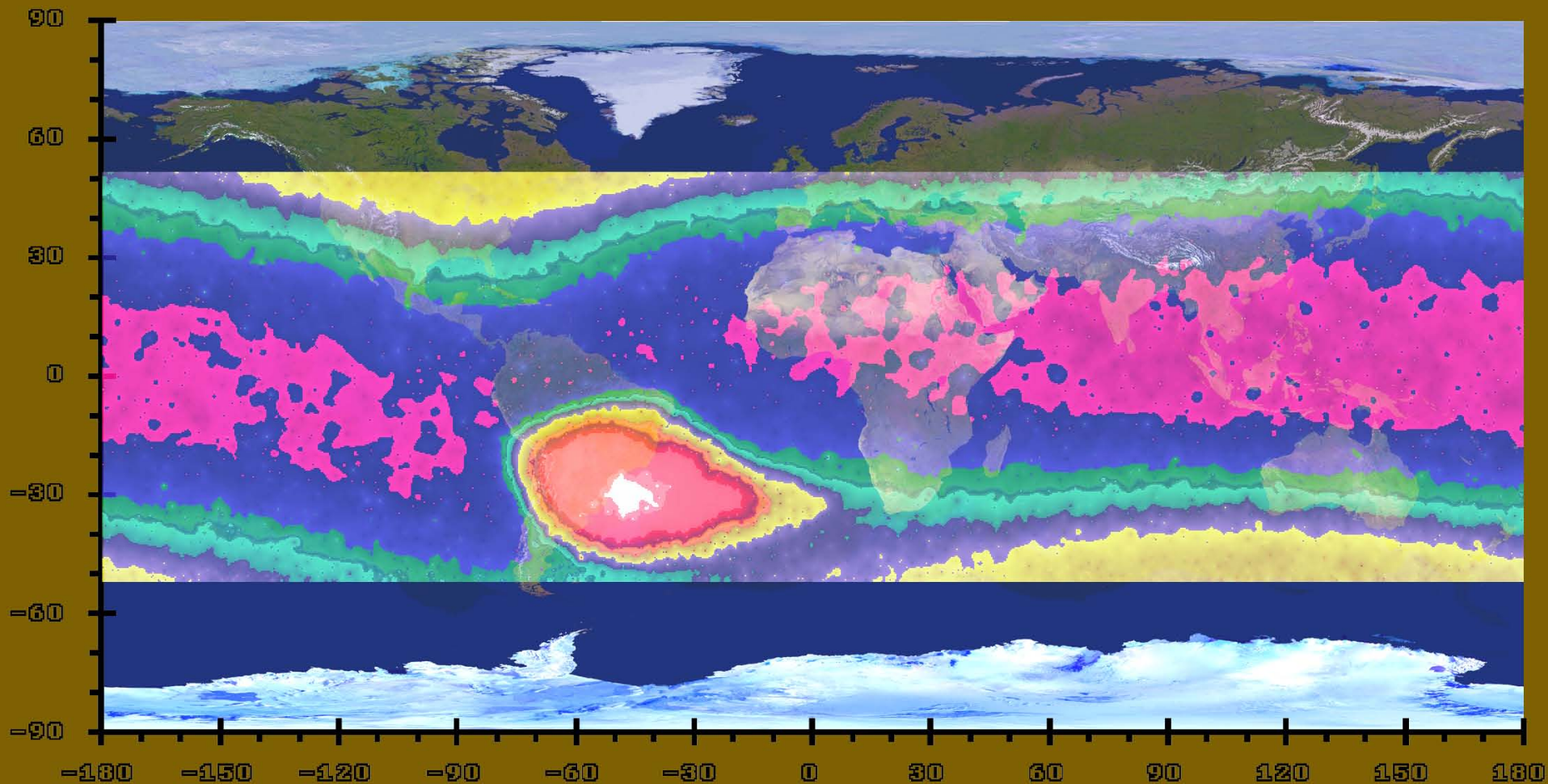
- FOR SOLAR PARTICLE EVENTS, DOSE EXTERNAL TO STATION (ALWAYS GREATER THAN ANY POINT IN THE HABITABLE VOLUME) WOULD BE AVAILABLE IN NEAR REAL-TIME.
- THUS, THE EXTERNAL SPECTROMETERS WOULD PROVIDE DIRECTIONAL CHARGE AND ENERGY SPECTRA, ABSORBED DOSE, LIMITED ELECTRON ENERGY SPECTRUM, AND LET SPECTRA, AS A FUNCTION OF TIME.
- DATA FROM EVCPDS CAN BE USED, BESIDES THE OPERATIONAL OBJECTIVES, TO:
 - (1) VALIDATE RADIATION TRANSPORT MODEL(s).
 - (2) CALCULATE DOSES AT POINTS NOT MAPPED BY CURRENTLY PLANNED ISS INSTRUMENTATIONS.
 - (3) CALCULATE ORGAN LEVEL DOSES - KEY TO RISK ASSESSMENT.
 - (4) IMPROVE TRAPPED BELT MODELS AND LEAD TO THE DEVELOPMENT OF TIME DEPENDENT TRAPPED BELT MODELS.
 - (5) PITCH ANGLE DISTRIBUTIONS AS A FUNCTION OF B, L, AND ENERGY, AND SCALE HEIGHT - KEY TO DIRECTIONAL TRAPPED BELT MODELS.
- ALTHOUGH THE INFORMATION OF THE ELECTRON FLUXES WOULD BE AVAILABLE, IT IS UNLIKELY TO HELP EVA PLANNING OR USE. THE REASON IS THAT THE PITCH ANGLE DISTRIBUTION CANNOT BE OBTAINED IN REAL-TIME, AND THE FLUXES ARE VERY STRONG FUNCTIONS OF THE PITCH ANGLE.

- INTERNAL CHARGED PARTICLE DIRECTIONAL SPECTROMETER
- THE IVCPDS UNIT IS NEARLY IDENTICAL TO ONE OF THE EXTERNAL PARTICLE SPECTROMETERS. IT PROVIDES THE SAME INFORMATION AS THE EVCPDS, BUT ONLY FROM THE DIRECTION IN WHICH IT IS MOUNTED ON THE SEAT TRACK.
- IT DIFFERS FROM AN EVCPDS IN MINOR DETAILS:
 - (1) IT CAN OPERATE ON BOTH 28 VDC AND 120 V STATION POWER, THUS ALLOWING IT TO OPERATE IN THE RUSSIAN SEGMENT.
 - (2) IT HAS A DISPLAY THAT THE CREW CAN READ, PROVIDING REAL-TIME DOSE, FOR EXAMPLE, IN CASE OF AN SPE.
 - (3) IT CAN BE ROTATED ALONG ITS AXIS AND HELP IN DETERMINING LOW DOSE DIRECTION IN THE EVENT OF AN SPE.
 - (4) IT CAN BE MOVED TO ANY LOCATION IN THE STATION WHERE THERE IS A UOP (Utility Outlet Panel).
- DATA FROM IVCPDS, IN CONJUNCTION WITH DATA FROM EVCPDS, AND KNOWLEDGE OF ISS MASS SHIELDING DISTRIBUTION IN THE VIEW DIRECTIONS:
 - (1) CAN BE USED TO VALIDATE RADIATION TRANSPORT MODEL(s);
 - (2) CALCULATE ORGAN LEVEL DOSES - WITHOUT INTRODUCING THE UNCERTAINTY OF SPACECRAFT SHIELDING DISTRIBUTION, AND RADIATION TRANSPORT MODEL(s);
 - (3) PROVIDE EASY ACCESS TO THE CREW OF DIRECTIONAL DOSES,
 - (4) DOSE DATA ARE NOT PLUGGED INTO THE ISS CAUTION AND WARNING SYSTEM.

TISSUE EQUIVALENT PROPORTIONAL COUNTER (TEPC)

- TEPC SIMULATES A 2 MICRON DIAMETER TISSUE. IT PROVIDES THE LINEAL ENERGY SPECTRUM IN THE TISSUE VOLUME AT ONE MINUTE INTERVALS.
- IT CONSISTS OF A DETECTOR ELEMENT AND A SPECTROMETER. THE SPECTROMETER CAN BE PLUGGED INTO ANY UOP. THE OMNIDIRECTIONAL DETECTOR HAS ABOUT AN 8 FOOT REACH FROM THE BACK OF THE SPECTROMETER. IT CAN OPERATE ON BOTH 28 VDC AND 120 V.
- IT PROVIDES ABSORBED DOSE IN INTERVALS OF 20, OR 60 SECONDS THAT ARE TELEMETERED TO THE GROUND IN REAL-TIME.
- IT HAS A DISPLAY THAT PROVIDES ABSORBED ACCUMULATED DOSE, DOSE RATE, ELAPSED TIME, TIME AND DATE, EVERY 30 SECONDS. THIS INFORMATION IS EASILY ACCESSIBLE TO THE CREW.
- IT HAS AN AUDIBLE AND A VISUAL ALARM IN CASE DOSE RATES EXCEED 4 TIMES THE MAXIMUM DOSE RATE EXPECTED DURING SOLAR MINIMUM THROUGH AN SAA PASS. THE THRESHOLD IS SET TO MINIMIZE FALSE ALARMS, BUT SMALL ENOUGH THAT NO SIGNIFICANT EVENT WOULD BE MISSED. THIS THRESHOLD WOULD NOT HAVE BEEN TRIGGERED BY THE NOVEMBER 6-8, 1997 EVENT.
- DATA ARE NOT ROUTED THROUGH THE CAUTION AND WARNING SYSTEM.

STATION TEPC PHOTO



Inclination = 51.6 deg.
Altitude ~ 381 km.
February 10, 1998 -
February 19, 1998

NASA-MIR 7 - Radiation Dosage TEPC - PRIRODA

0 nGy/min 6500

- DATA FROM ISS TEPC WOULD BE USED TO:
- OPERATIONAL DECISIONS ABOUT SAFE LOCATIONS IN THE EVENT OF AN SPE.
- PROVIDE A DIRECT MEASURE OF THE RADIATION QUALITY FACTOR AND THUS THE IMPORTANT DOSE EQUIVALENT.
- WOULD HELP TO DETERMINE DRIFT OF THE SAA WITH TIME AND IMPROVING MODELS OF THE TRAPPED BELTS.
- UNLIKE THE EVCPDS OR IVCPDS, THE TEPC DOSE EQUIVALENT INCLUDES LIMITED INFORMATION ABOUT SECONDARY NEUTRONS.